Reassessment of the Ordovician brachiopods from the Budleigh Salterton Pebble Bed, Devon

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Synopsis

The Ordovician part of the brachiopod fauna from the quartzite pebbles found in the Triassic Budleigh Salterton Pebble Bed, Devon, is reassessed, chiefly using the nineteenth-century collections made by Vicary, Valpy and others and originally figured by Salter and Davidson. Davidson's overlooked conclusion of two separate Ordovician ages is confirmed. The older Arenig has a bizarre fauna of large inarticulate brachiopods, and there is a younger and more abundant fauna of late Llandielo age. The European affinities of the fauna are confirmed and the taxonomy of the late Llandielo fauna (including some comparative material from France) is revised. The species *Corineorthis erratica* (Davidson), *Tafilaltia valpyana* (Davidson) and *Salopia? pulvinata* (Salter) are redescribed in detail, and other species placed in synonymy with them.

Introduction

The value of old collections is well demonstrated by the brachiopods and other shelly fossils found during the nineteenth century in pebbles from the conglomerates of Triassic age near Budleigh Salterton, Devon (Fig. 1). Although it was a Mr Carter who found the first fossils in the pebbles in about 1835, it was an enthusiastic amateur geologist, W. Vicary, who first made an extensive collection of the shells from about 1860, and brought them to the attention of the well-known palaeontologist J. W. Salter. Salter encouraged Vicary to give a short account of the rocks to the Geological Society of London (Vicary 1864). Salter (1864) appended a 'note on the fossils', containing descriptions and illustrations of 37 taxa of many phyla. Vicary's collection was bequeathed to the British Museum (Natural History) in 1903, and it was joined there in 1910 by the collection of another enthusiastic amateur, R. H. Valpy, after the latter's death.

Salter was astute in perceiving the central European affinities of the Budleigh Salterton fauna, which was quite unlike any of those faunas found elsewhere in Britain (apart from Cornwall) in rocks of the same age. Salter assessed this age as 'Lower Silurian' (i.e. Ordovician in modern terms), although he was puzzled by some shells which he interpreted as the oldest spiriferide brachiopods. The shells were subsequently reassessed by T. Davidson (briefly reported in 1866 : 67 and elaborated in 1870), the greatest of the nineteenth-century brachiopod workers. He then recognized that the pebbles, although all similar in their quartzite lithology, could be assigned to two separate ages, Ordovician and Devonian; it was the latter which included the questionable spiriferides. Davidson figured the brachiopod fauna in a series of publications (1866–71, 1870, 1881*a*). Davidson's collection from Budleigh Salterton, largely given to him by other collectors but containing many type specimens, was bequeathed to the Museum in 1885. Good specimens are extremely difficult to collect from the Budleigh Salterton Pebble Beds and thus the Museum

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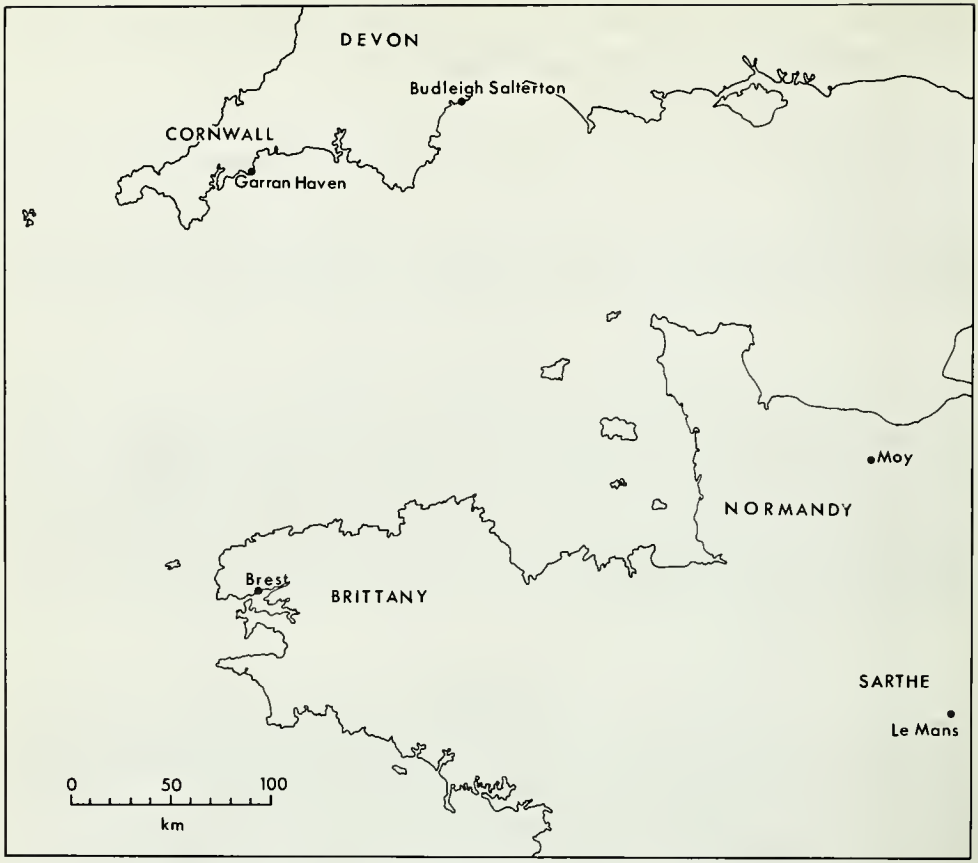


Fig. 1 Locality map showing the relative present-day positions of Budleigh Salterton, Devon, Gorran Haven, Cornwall and the Armorican Peninsula, France.

possesses the largest, and indubitably the most important, collection of brachiopods from that area, which has not been critically reassessed for a century. The present paper deals only with the Ordovician part of the fauna; the Devonian brachiopods will form the topic of a subsequent publication. Davidson, in a later review (1880 : 339), also realized that there were two separate Ordovician ages represented by the Budleigh Salterton brachiopods. The older of these he identified as 'Grès Armoricain – Lowest portion of Llandeilo', and the younger as 'Grès de May – Caradoc' (Davidson's stratigraphical terminology compared with modern usage can be found in Cocks 1978 : fig. 1). This important conclusion appears, however, to have been overlooked by all subsequent workers. The older horizon is represented only by the large inarticulate brachiopods and the younger by the more common pebbles dominated by '*Orthis budleighensis*'.

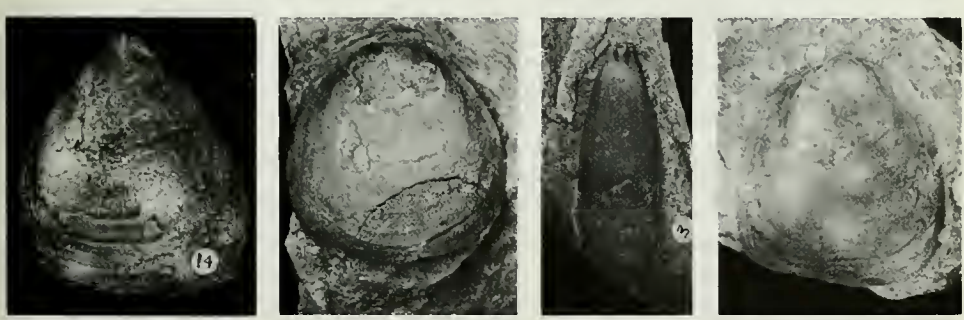
The Ordovician brachiopods found in the Budleigh Salterton pebbles are very similar to those found *in situ* in the Armorican Peninsula of Brittany and Normandy, France, and also to some extent in the Gorran Haven area of Cornwall (Fig. 1). Sadler (1974) has reviewed the Gorran Quartzites and their trilobite fauna, assigned to them a Llandeilo, possibly a late Llandeilo, age and (1974 : 74) recorded comparable trilobites from Budleigh Salterton pebbles. During the last 20 years much has been published on the Ordovician of the Armorican massif, the stratigraphy of which is now well known (see summaries by Babin *et*

al. 1976 *a, b*). While a few French brachiopods have been revised recently (Melou 1973, 1975), most of the Armorican brachiopod fauna remains undescribed and we take the opportunity here of illustrating and measuring some brachiopods from Normandy, based on collections made by Sir R. I. Murchison, the founder of the Silurian system, which came to the Museum in 1911 with all the other foreign specimens of the Geological Society of London.

The Arenig Fauna

The brachiopod fauna of the Grès Armoricain in the Armorican Peninsula, France, was originally described (without illustrations) by Rouault (1850), and later revised and extended by Davidson (1880, 1881 *b, c*). Davidson's original French material, presented to him by Lebesconte, Guillier, Morière and others, is also now in the British Museum (Natural History), together with his notes and correspondence and the original drawings for the published plates. No primary work has been carried out since then on the brachiopod fauna, although new generic names were subsequently given to two of the species. Henry (1980) has revised the sparse Grès Armoricain trilobite fauna, which consists of *Ogyginus armoricanus* (Tromelin & Lebesconte), *Platycoryphe heberti* (Lebesconte) and *P. dangeardi* Henry, and endorsed the Arenig age deduced by previous workers. Although there is no internal evidence to be sure of the detailed age of the Grès Armoricain faunas within the Arenig, Dr R. A. Fortey has suggested to us that a middle Arenig age appears the most probable from an assessment of contemporary faunas elsewhere in transgressive situations comparable to that seen in the Grès Armoricain. Davidson's work (1880 on Brittany, 1881*b* on Normandy and 1881*c* on Sarthe) revealed the following brachiopods to be present in the French Grès Armoricain (with updated generic names):

	Brittany	Normandy	Sarthe
Ectenoglossa leseueuri (Rouault, 1850)	×	×	×
Lingulepis crassipyxis Havlíček, 1980			×
Lingulobolus brimonti (Rouault, 1850)	×	×	
Lingulobolus hawkei (Rouault, 1850)	×	×	
Pseudobolus ? *slateri* (Davidson, 1866)	×	×	
Tomasina criei (Davidson, 1881)			×



2 3 4 5

Figs 2–5 Inarticulate brachiopods of Arenig age from the Budleigh Salterton Pebble Bed. Fig. 2, B 21518 *Lingulobolus hawkei* (Rouault, 1850), × 1·0; the specimen is that figured by Salter (1864 : pl. 17, fig. 4) as *Lingula rouaulti* sp. nov., and was subsequently selected (Cocks 1978 : 12) as the lectotype of the latter species; W. Vicary Coll. Fig. 3, B 21504 *Pseudobolus*? *salteri* (Davidson), × 1·2; the lectotype (sel. Cocks 1978 : 13), originally figured by Davidson (1866 : pl. 1, fig. 28); W. Vicary Coll. Fig. 4, B 21516 *Ectenoglossa lesueuri* (Rouault, 1850), × 1·0; the specimen previously figured by Salter (1864 : pl. 17, fig. 1) and Davidson (1866 : pl. 1, fig. 3); W. Vicary Coll. Fig. 5, B 21514 *Lingulobolus brimonti* (Rouault, 1850), × 1·3; the specimen figured by Salter (1864 : pl. 17, fig. 2) and Davidson (1866 : pl. 1, fig. 21) as *Lingula hawkei* Rouault; W. Vicary Coll.

No Arenig trilobites have yet been noted in the Budleigh Salterton faunas, but the brachiopods *Ectenoglossa leseueuri* (Fig. 4), *Lingulobolus brimonti* (Fig. 5), *L. hawkei* (Fig. 2) and *Pseudobolus*? *salteri* (Fig. 3) are all known (Salter 1864, Davidson 1870, 1881*a*), and thus match exactly the Grès Armoricain inarticulate brachiopod fauna of Brittany and Normandy. The lack of illustrations in Rouault's original work led the first wave of subsequent revisers astray in their identifications of *brimonti* and *hawkei*. The attributions published by Salter (1864) and Davidson (1866, 1870) are thus in error, but this was rectified subsequently by Davidson (1880, 1881*a*) and led to the correct synonymizing of Salter's *rouaulti* (whose lectotype is refigured here, Fig. 2) with *hawkei*. Davidson's illustrations are so good that further redescription of the fauna is not given here, although the fauna as a whole could usefully be revised in the light of a thorough reappraisal of inarticulates and possibly bivalves of Arenig age from the whole central European area, including Bohemia and the Iberian Peninsula. Havlíček (1980) has described a comparable fauna from the Montagne Noire, southern France.

The Llandeilo Fauna

In contrast to the bizarre inarticulate fauna found in the pebbles of Arenig age, the Llandeilo age pebbles from Budleigh Salterton show an overwhelming dominance of articulate brachiopods, in particular the enteletacean previously commonly identified as *Orthis budleighensis* and which is now known to be *Tafilaltia valpyana*. The brachiopod fauna is not a diverse one, and consists of the three orthide species described in detail below, rare lingulides identified by Davidson as *Lingula morieri* Tromelin, 1876, and a single specimen, BM(NH) Palaeont. Dept. B 21525, identifiable as *Porambonites* sp. This last was figured by Salter (1864 : pl. 17, fig. 9) and identified correctly by him, even though it was later unaccountably placed in the synonymy of *pulvinata* by Davidson (1881*a* : 358). There are no other fossils on the same block, and thus it is just possible that the specimen could be of Arenig age; however this large (length 28·5 mm, width 39·2 mm) brachial valve appears to be more similar to Llandeilo and Caradoc forms of the genus. The specimen (B 21531) figured as *Terebratula*? sp. by Davidson (1870 : pl. 4, fig. 11; 1881*a* : pl. 41, fig. 23) is a monoplacophoran resembling *Vallatotheca*, kindly reidentified by Dr N. J. Morris. There are also bivalves, gastropods, crinoids and trilobites in the late Llandeilo fauna, all awaiting revision apart from *Neseuretus tristani*, but all relatively uncommon when compared with the dominant brachiopods.

The fauna has its nearest geographical comparison with that from the Gorran Quartzites of the Gorran Haven area, Cornwall (Sadler 1974), sharing with it the trilobite *Neseuretus tristani* (Brongniart). However, the Cornish beds also yield a common large orthid (figured by Davidson, 1881*a*, as *Orthis calligramma* and to be revised by M. G. Bassett), which is not present in the Budleigh Salterton pebbles, and the other Cornish brachiopods include congeneric *Corineorthis* and heterorthids, but not species in common. The Budleigh Salterton Llandeilo pebbles probably have their closest faunal affinity with the fauna from the Grès de May Formation in Normandy. Detailed comparison is difficult, since the French brachiopod fauna has not yet been properly described, but the opportunity is taken here (see systematic section below) to demonstrate the specific identity of the commonest form at both Budleigh Salterton and in the Grès de May, *Tafilaltia valpyana* (Davidson). It is relevant to note that the same species (previously described as *Tafilaltia dalmanelloides*) is also present in the Llandeilo age Skalka Quartzite of Bohemia (Havlíček 1970). The age of this part of the Budleigh Salterton pebble fauna is almost certainly late Llandeilo, although the upper part of the Grès de May represents deposition which probably continued on into early Caradoc times (Babin *et al.* 1976*a* : 381).

Systematic Palaeontology

All the figured and quoted specimens are in the British Museum (Natural History) (B and BB). In general the specimens are well preserved, but the recemented quartzite lithology precludes the preservation of the very fine details of ornament.

Class **ARTICULATA** Huxley, 1869

Order **ORTHIDA** Schuchert & Cooper, 1932

Suborder **ORTHIDINA** Schuchert & Cooper, 1932

Superfamily **ORTHACEA** Woodward, 1852

Family **PLECTORTHIDAE** Schuchert & Le Vene, 1929

Subfamily **PLECTORTHINAE** Schuchert & Le Vene, 1929

Genus ***CORINEORTHIS*** Stubblefield, 1939

Corineorthis erratica (Davidson, 1869)
(Figs 6–11)

1869 *Orthis Berthoisi* ? var. *erratica* Davidson : 233; pl. 32, figs 21–28.
1870 *Orthis Berthoisi* ? var. *erratica* Davidson; Davidson : 83; pl. 5, figs 13–16.
1881*a* *Orthis Berthoisi* var. *erratica* Davidson; Davidson : 356; pl. 41. figs 1–9.
1978 *Svobodaina* ? *erratica* (Davidson) Cocks : 74.

Description. Large dorsibiconvex to convexoplane orthide with obtuse cardinal angles and incipient development of weak plication; pedicle valve with subcircular to subpentagonal outline and averaging 83% as wide as long in 5 specimens; brachial valve averaging 80% as wide as long in 7 specimens, and between one-quarter and one-third as deep as long; ventral interarea slightly curved and apsacline, with prominent growth striations; open, wide delthyrium with conspicuous pedicle callist; short anacline dorsal interarea, with open notothyrium largely filled by posterior part of myophore; radial multicostellate ornament with 3 to 4 ribs per mm at 5 mm length; a few prominent concentric growth lines.

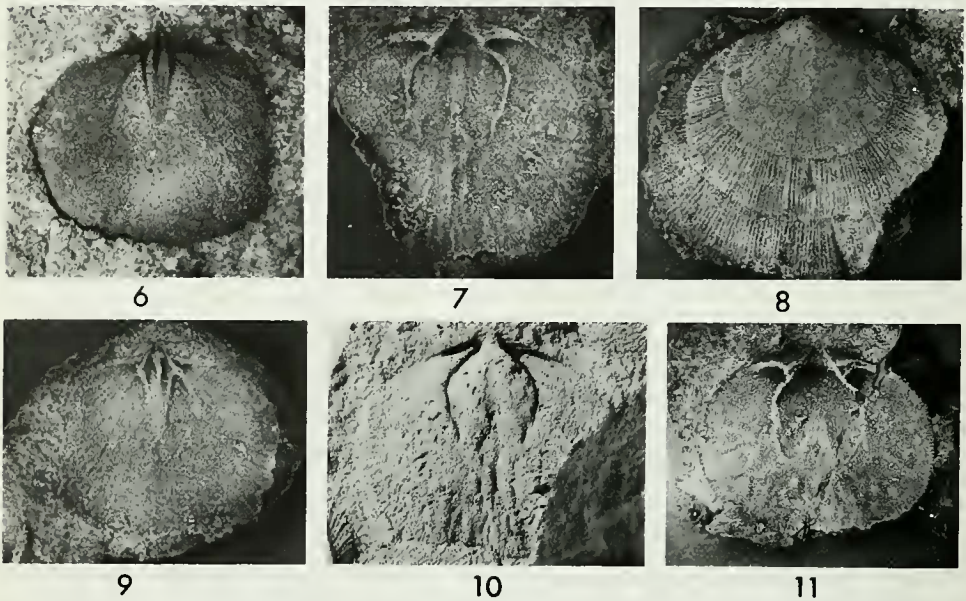
Teeth short, stout, and supported by dental plates extending anteriorly for up to 21% of valve length and diverging at about 90°; well-impressed ventral diductor muscle scars elongately bilobed, about 85% as wide as long, extending anteriorly for an average of just over 50% of valve length and enclosing elongate adductor scars which extend anteromedially to link with the vascular impressions.

Cardinal process simple, with well-developed triangular myophore and simple blade-like shaft extending anteriorly across the notothyrial platform onto median septum; elongate brachiophore bases average about one-quarter valve length, initially diverging for about two-thirds of their length, then converging across the flanks of the platform to merge anteriorly with the short median septum. Faint elongate muscle scars, about 85% as wide as long, expanding anteriorly, with maximum width in the mid-part of the valve, although the posterior pair of scars are most deeply impressed to form pits.

Material. Lectotype of *erratica* (selected Cocks 1978 : 74) B 20936 (Figs 7, 8, 10), external and internal moulds of a pedicle valve, originally figured by Davidson (1869 : pl. 32, figs 21–23); R. H. Valpy Collection, from late Llandeilo pebble in Trias, Budleigh Salterton Pebble Bed, Devon. Additional material in the British Museum (Natural History) : 11 brachial valves and 4 pedicle valves also from the Budleigh Salterton Pebble Bed. Specimens of *Corineorthis* also probably attributable to *erratica*, e.g. B 13289, are known from the Grès de May of St Germain, France.

Discussion. Examination of the material described as *Orthis berthoisi* var. *erratica* by

Davidson (1869) shows clearly that it is congeneric with material from Cornwall described as *Corineorthis decipiens* by Stubblefield (1939), itself recently recognized by M. G. Bassett as a junior synonym of *Orthis berthoisi* var. *cornubiensis* Davidson, 1881. Davidson (1881*a* : 355–7) also discussed the problem of *Orthis berthoisi* itself, which comes from the slates of La Couyère, Normandy (Rouault 1849 : 68; pl. 2, figs 4–4c). Topotype material of *berthoisi* (e.g. B 13233 in the Davidson Collection *ex* Tromelin), although severely crushed, leads us to agree with Davidson that *erratica* and *berthoisi* are not the same: until Rouault's types are revised, perhaps *berthoisi* is best regarded as a *nomen dubium*. The La Couyère slates are now known to form part of the Riadan Formation, which is late Ordovician in age (Babin *et al.* 1976*a* : 374).



Figs 6–11 *Corineorthis erratica* (Davidson, 1869) from pebbles of late Llandeilo age, Budleigh Salterton Pebble Bed, Devon. Figs 6, 9, B 20936 (additional brachial valve on lectotype block and latex cast of it), × 2·0. Figs 7, 8, 10, B 20936, latex cast of internal mould, latex cast of external mould and internal mould of pedicle valve, lectotype (sel. Cocks 1978 : 74), originally figured by Davidson (1869 : pl. 32, figs 21–23), × 1·5; R. H. Valpy Coll. Fig. 11, B 13284, latex cast of pedicle valve internal mould, × 1·5; T. Davidson Coll. *ex* W. Vicary.

Available statistical data indicate that *C. erratica* and *C. pustula* Williams, from the type Llandeilo area, although showing no significant differences in the outline of either valve or the shape of the cardinalia, do differ in their ventral diductor scars, which are more splayed in *erratica* (85% of length, compared with 62% in *pustula*). The coarse texture of the Budleigh Salterton sediments makes it hard to determine whether or not the internal pustules and characteristic exopunctae of *pustula* are present in *erratica*. *C. erratica* also has a better-developed myophore than *pustula*, presumably indicating a better-developed diductor attachment site to complement the larger ventral scars, and we continue to recognize them as two separate species. *C. erratica* has muscle bounding ridges which are laterally curved, in contrast to the straight ridges present in *C. cornubiensis*.

Superfamily **ENTELETACEA** Waagen, 1884

Family **HETERORTHIDAE** Schuchert & Cooper, 1931

Genus ***TAFILALTIA*** Havlíček, 1970

Tafilaltia valpyana (Davidson, 1869)
(Figs 12–23, 30, 31)

1864 *Orthis redux* Barrande; Salter : 294; pl. 17, fig. 7 (*non* Barrande, 1848).
1869 *Orthis redux* Barrande; Davidson : 224; pl. 28, figs 6–9 (*non* Barrande, 1848).
1869 *Orthis testudinaria* Dalman; Davidson : 226 *pars*; pl. 28, fig. 22, *non* figs 13–21, 23, 24 (*non* Dalman, 1828).
1869 *Orthis Valpyana* Davidson : 235; pl. 32, figs 29–33.
1870 *Orthis redux* var. *budleighensis* Davidson : 82; pl. 5, figs 9–12.
1870 *Orthis Valpyana* Davidson; Davidson : 83; pl. 5, figs 23–25.
1881*a* *Orthis budleighensis* Davidson; Davidson : 358; pl. 41, figs 12–20; pl. 42, figs 16–25.
1881*a* *Orthis Valpyana* Davidson; Davidson : 361; pl. 41, figs 21, 22.
1970 *Tafilaltia dalmanelloides* Havlíček : 20; pl. 4, figs 1–8.
1977 *Tafilaltia dalmanelloides* Havlíček; Havlíček : 115; pl. 11, figs 3–5, 7, 8.
1978 *Howellites ? budleighensis* (Davidson) Cocks : 65.
1978 *Heterorthina valpyana* (Davidson) Cocks : 74.

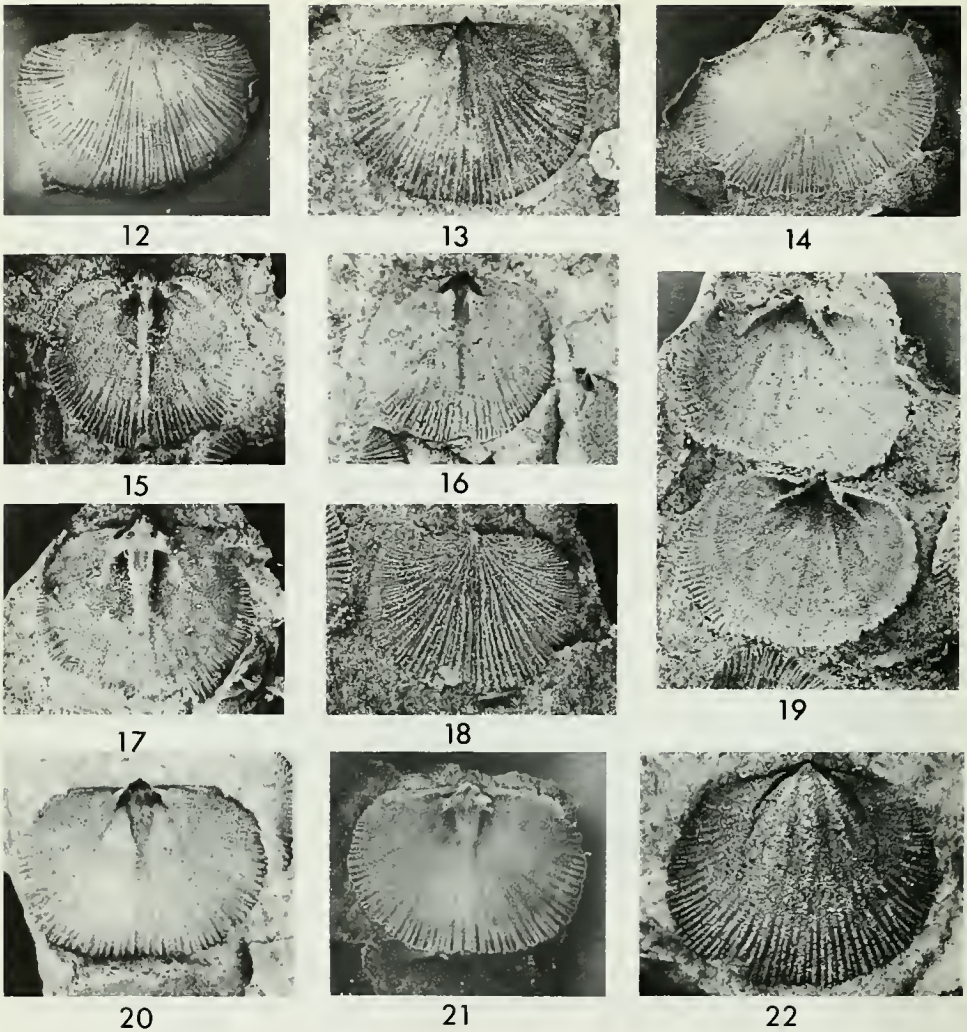
DESCRIPTION. Fairly small planoconvex to ventribiconvex transverse heterorthinid with brachial valve averaging 80% as long as wide in 46 specimens; pedicle valve averaging 83% as long as wide in 33 specimens and 25% as deep as long in 10 specimens; ventral interarea short, apsacline, with wide, open delthyrium, dorsal interarea short anacline, notothyrium completely filled by cardinal process; radial ornament of fine costellae, numbering 5 to 6 per mm 5 mm anteriorly of the umbo, which curve posterolaterally to merge with the hinge line.

Ventral interior with small teeth supported by low, widely-divergent dental lamellae extending laterally for about half the valve width and anteriorly for about one-quarter the valve length; pedicle callist well developed; muscle field large, usually poorly impressed anteriorly but averaging 56% of valve length and 99% as long as wide in 4 specimens in which the anterior edge was more strongly impressed; muscle field slightly flabellate with lateral margins of diductor scars less well developed than the median margins, which enclose poorly differentiated adductor scars; vascular canals, separated by ridges, can be quite deeply impressed.

Dorsal interior with well-developed, ponderous cardinal process with a raised posterior myophore, supported anteriorly by a low, broad shaft barely distinguishable from the supporting median septum; triangular posterior platform of myophore with prominent median ridge raised above lateral margins; brachiophores short and blade-like, with bases which average 17% as long as valve length and 64% as long as wide in 33 specimens; sockets narrow and well defined, and without fulcral plates; muscle scars elongate and variably impressed, quadripartite and averaging 46% of valve length and 85% as wide as long in 15 specimens.

MATERIAL. Lectotype of *valpyana* (selected Cocks 1978 : 74) B 21533, external mould (Fig. 12) and counterpart internal mould of a pedicle valve, the original of Davidson (1869 : pl. 32, figs 29–31); W. Vicary Collection, from late Llandeilo pebble in Trias, Budleigh Salterton, Devon. Additional material: over 300 specimens from other blocks in the Budleigh Salterton Pebble Bed in the Vicary and Valpy Collections, including B 21616, the lectotype of *budleighensis* Figs 15, 16). Also known from Perhaver Quartzite, Gorran Haven, Cornwall; the Grès de petit May, Normandy, France; and the Skalka Quartzite of Bohemia, Czechoslovakia, including the holotype of *dalmanelloides*, from Chrbina Hill, near Nenačovice (Havlíček 1970 : 20–21).

DISCUSSION. A few relatively large heterorthid specimens, distinguished as the new species *valpyana* by Davidson (1869), closely resemble the much more numerous and smaller form



Figs 12–22 *Tafilaltia valpyana* (Davidson, 1869) from pebbles of late Llandeilo age, Budleigh Salterton Pebble Bed, Devon. Fig. 12, B 21533, latex cast of external mould of a pedicle valve, lectotype (sel. Cocks 1978 : 74), originally figured by Davidson (1869 : pl. 32, fig. 29), × 2·0; W. Vicary Coll. Fig. 13, B 21524, internal mould of a brachial valve, Davidson (1869 : pl. 32, figs 32, 32a), × 1·8; W. Vicary Coll. Fig. 14, B 21509, latex cast of the internal mould of a brachial valve, × 2·0. Figs 15, 16, B 21616, latex cast and internal mould of a brachial valve, lectotype of *budleighensis* (sel. Cocks 1978 : 65), originally figured by Davidson (1870 : pl. 5, fig. 12 lower right), × 3·0. Fig. 17, latex cast of the interior of another brachial valve on the same slab as Figs 15 and 16, × 2·0. Fig. 18, BB 95940, latex cast of the external mould of a brachial valve, × 3·0; W. Vicary Coll. Fig. 19, B 21621, latex cast of two internal moulds of pedicle valves, × 3·0; W. Vicary Coll. Figs 20, 21, BB 95941, internal mould of a brachial valve and latex cast of it, × 2·4; W. Vicary Coll. Fig. 22, BB 95942, internal mould of a pedicle valve × 3·0; W. Vicary Coll.

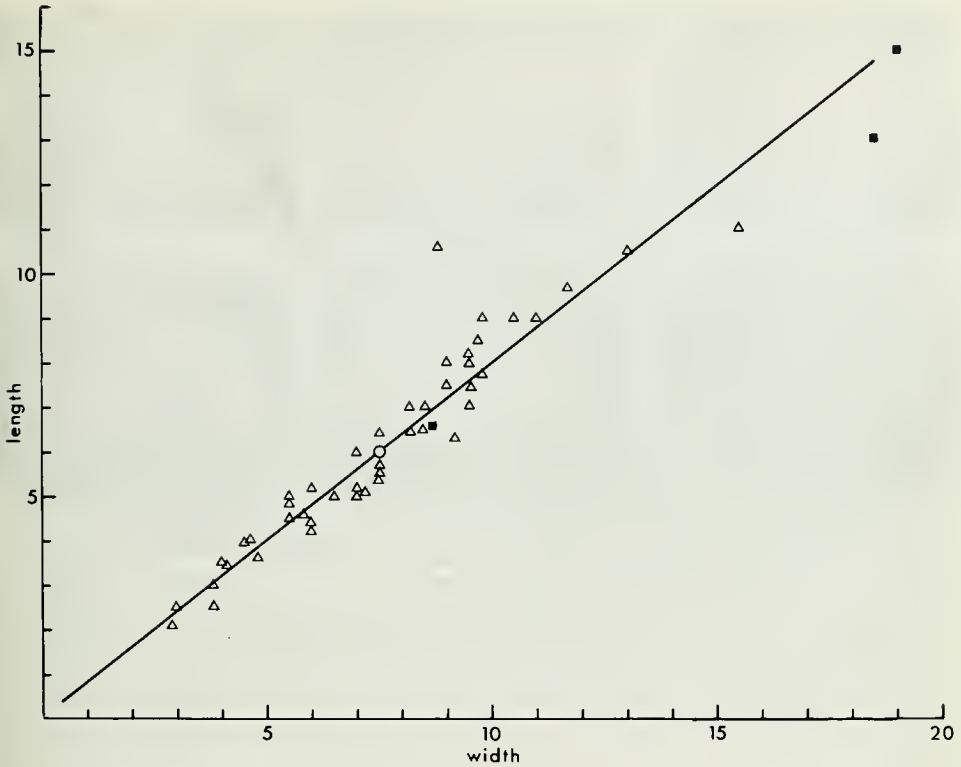
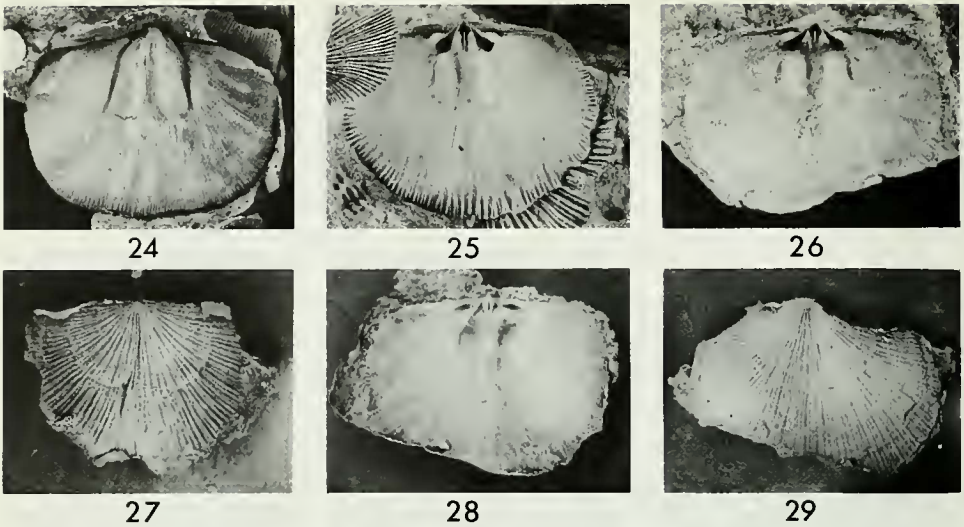


Fig. 23 Length–width measurements of brachial valves of *Tafilaltia valpyana* (Davidson, 1869), from pebbles of late Llandeilo age in Trias, Budleigh Salterton, Devon. The solid squares represent the three specimens figured by Davidson as *valpyana*; the open triangles represent 45 specimens, including the lectotype, of *budleighensis* from the same locality. The average (of the *budleighensis* sample) and regression line of the length on the width are also shown.

with which they occur. This smaller form had been recognized by Salter (1864), in his first descriptions of Budleigh Salterton fossils, as being similar to species from the Bohemian province, and he had identified it as *Orthis redux* Barrande, a species since made the type of *Drabovia* Havlíček, 1951. It was not until 1870 that Davidson felt he could formally separate the two forms, when he gave the Devon brachiopod the varietal name of *budleighensis*. We can now demonstrate (Fig. 23) that *valpyana* and *budleighensis* exhibit similar growth ratios, and so consider the better-known latter name to be a junior synonym.

The species can be readily identified as an heterorthid, and our initial reaction was to compare it with an early undescribed species of *Heterorthis* from the late Llandeilo of Dyfed, Wales (Addison 1974). Similarly, M. G. Bassett has assigned closely related material from Cornwall to the genus *Heterorthina*. However, comparisons between *valpyana* and *praeculta*, the type species of *Heterorthina*, whilst showing no significant difference in valve outline, relative length of muscle scars and dorsal cardinalia, do show a significant difference in the relatively greater depth of the pedicle valve ($5\% > p > 2\%$), and we have also noted that *H. praeculta* has more clearly differentiated and more deeply impressed ventral muscle scars, particularly towards their anterior. The opportunity is taken here to illustrate some topotype specimens of *Heterorthina praeculta* (Figs 24–29), including the lectotype (selected Cocks 1978 : 74) which has not been figured since its original illustration by Bancroft (1928:



Figs 24–29 Topotype specimens of *Heterorthina praeculta* Bancroft, 1928, from the Cheney Longville Flags (Caradoc: Marshbrookian), south side of road from Cwm Head to Marshbrook, Shropshire, Grid Reference SO 437896. Fig. 24, BB 9152, internal mould of a pedicle valve, lectotype (sel. Cocks 1978 : 74), originally figured by Bancroft (1928 : pl. 2, fig. 18), × 1·5; B. B. Bancroft Coll. Figs 25, 29, BB 7288, internal mould of a brachial valve and latex cast of the external mould, × 2·0; J. M. Hurst Coll. Fig 26, 28, BB 68827, internal mould and latex cast of a brachial valve, × 2·0; B. B. Bancroft Coll. Fig. 27, BB 72289, latex cast of the external mould of a brachial valve, × 3·0; J. M. Hurst Coll.

pl. 2, fig. 18). Although the cardinalia of *valpyana* resembles some variants of *Heterorthina kerfornei*, such as the specimen figured by Melou (1975 : pl. 23, fig. 5), other specimens of *kerfornei*, and indeed most *Heterorthina* generally, differ from *valpyana* in possessing a cleft shaft supporting the myophore (cf. Hurst 1979).

In our opinion, the species is best assigned to *Tafilaltia* Havlíček, a genus considered ancestral to *Heterorthis* by Havlíček (1977) and in its earlier species showing poorly differentiated ventral musculature, as in *valpyana*. The ponderous tripartite myophore and absence of chilidium is diagnostic of *Tafilaltia*, and indeed Havlíček (1970 : 17–21) included material from the Grès de May within his *Tafilaltia dalmanelloides*, which is accepted here, and is why we have suppressed the latter species as a junior synonym of *valpyana*. Comparisons between *valpyana* from Budleigh Salterton and apparently conspecific French material (Fig. 30) from the Grès de petit May, May, Normandy (B 85258), showed no significant differences in any of the nine characters tested, i.e. the outline of both valves (data for 23 brachial valves included in Fig. 31), the relative depth of the pedicle valve, the shape and relative length of the dorsal cardinalia, and the shape and relative length of both dorsal and ventral muscle scars. Similarly no significant differences in dorsal outline or shape and relative length of ventral muscle scars can be detected through comparisons made with Addison's unpublished statistics (1974: tables 14 and 15) of the small heterorthid mentioned above (*Heterorthis* sp. nov.) from late Llandeilo to early Caradoc sandstones of Lampeter Velfrey, Dyfed. However, this undescribed form differs from *valpyana* in its sharply-differentiated ventral muscle scars, and perhaps represents a direct link between *Tafilaltia* and better-known Caradoc *Heterorthis* such as *Heterorthis alternata* (J. de C. Sowerby) (see Williams 1963).

Fig. 30 *Tafilaltia valpyana* (Davidson, 1869) from the Grès de petit May, May, near Caen, Normandy, France. B 85258, part of a slab containing numerous external and internal moulds of both valves, × 3·0; Sir R. I. Murchison Coll. *per* Geological Society of London Coll., pres. 1911.

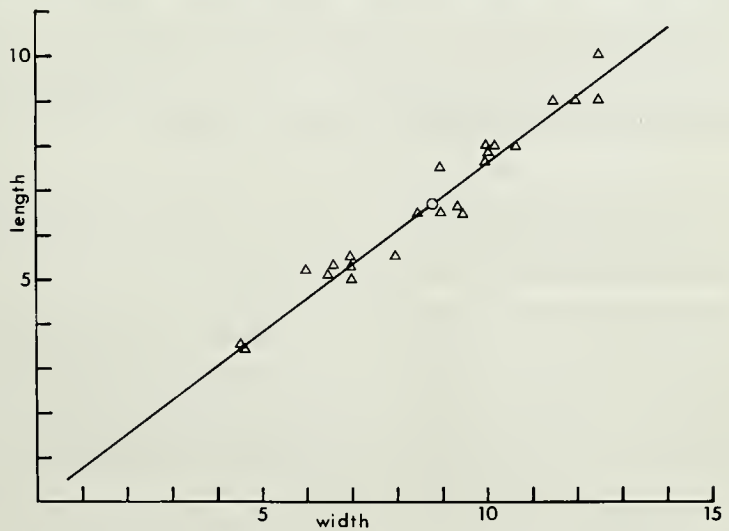


Fig. 31 Length–width measurements of 23 brachial valves of *Tafilaltia valpyana* (Davidson, 1869) from the Grès de petit May, May, near Caen, Normandy, France, all on slab B 85258 (Fig. 30). The average and regression line of the length on the width are also shown.

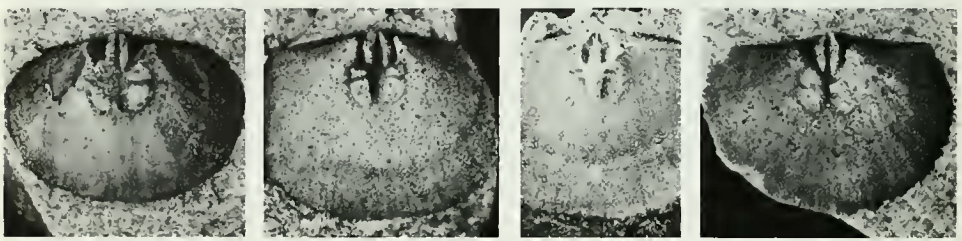
Family **LINOPORELLIDAE** Schuchert & Cooper, 1931

Genus ***SALOPIA*** Williams, 1955

Salopia ? pulvinata (Salter, 1864)
(Figs 32–35)

1864 *Orthis pulvinata* Salter : 294; pl. 17, fig. 8.
1870 *Orthis pulvinata* Salter; Davidson : 83 *pars;* pl. 5, figs 17, 19, ? fig. 18.
1881*a* *Orthis pulvinata* Salter; Davidson : 357; pl. 41, figs 10, 11.
1978 *Pionodema ? pulvinata* (Salter) Cocks : 80.

Description. Large, transverse linoporellid with brachial valve averaging 71% as long as wide (range 71–72%), and between 19 and 26% as deep as long in 3 valves. Dorsal interarea short, flat, anacline, with wide open notothyrium. Ornament poorly known, consisting of faint fine radial costellae. Cardinal process simple, blade-like, consisting of anteriorly widening shaft merging with notothyrial platform. Brachiophores short, with convergent bases extending forward for about one-fifth to one-quarter valve length; sockets narrow, with small curved fulcral plates. Dorsal adductor scars elongate and quadripartite, averaging 49% as long as valve (range 47–52%) in three valves, with anterior pair of scars larger than posterior pair. The muscle field is divided by a broad median septum. Pedicle valve unknown.



32 33 34 35

Figs 32–35 *Salopia* ? *pulvinata* (Salter, 1864) from late Llandeilo pebbles in Trias, Budleigh Salterton, Devon. Fig. 32, B 21523, internal mould of a brachial valve, lectotype (sel. Cocks 1978 : 80), originally figured by Salter (1864 : pl. 17, fig. 8), × 1·5. Figs 33, 34, BB 70910, internal mould of a brachial valve and latex cast of it, × 2·5; W. Vicary Coll. Fig. 35, B 13051, internal mould of a brachial valve, × 2·5; T. Davidson Coll. *ex* Winwood.

Material. Lectotype B 21523 (sel. Cocks 1978 : 80), the part and counterpart of a brachial valve (Fig. 32), figured Salter (1864 : pl. 17, fig. 8); from Ordovician pebble in Trias, Budleigh Salterton, Devon. Other material: two other brachial valves, B 13051 and BB 70940, both internal moulds only, from the same locality.

Discussion. Only three brachial valves and no pedicle valve are known of *pulvinata*; although Davidson (1881*a* : 358) states that 'M. de Tromelin informs me that *O. pulvinata* occurs in company with *O. Berthoisi,* var. *erratica,* at Saint Germain-sur-Ille, La Bouëxiere, Champeaux (Ille-de-Vilaine), and in other places', no French material is available for comparison. In the absence of any pedicle valves the generic determination can only be provisional, hence the query, but the three brachial valves are certainly similar to *Salopia turgida* (M'Coy), as recently revised by Lockley & Williams 1981, particularly in their simple blade-like cardinal processes and quadripartite adductor muscle scars. However, *pulvinata* is more transverse (71% as long as wide, as compared with 88% for *turgida*), the brachiophores of *turgida* are relatively long in comparison with the quite short brachiophores of *pulvinata*, and the adductor muscle scars are more deeply impressed and less elongate in *pulvinata* than in *turgida.* A full revision of these species, and their relationship

to the other species of *Salopia*, such as *S. globosa* (Williams, 1949), *S. triangularis* (J. de C. Sowerby, 1839) and the type species, *S. salteri* (Davidson, 1869) and its subspecies *gracilis* Williams, 1955, must await the discovery of pedicle valves at Budleigh Salterton or the collection of more material in France.

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